

Adventures in science

John M. Scott, s.J.

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*Dedicated to my father
who introduced me to the
magic of numbers
and showed me the
wonders of science*

Yesterday Jules Verne could only dream of spaceships soaring into the vast realms of the Milky Way. Today, from Cape Canaveral, man is boldly and gallantly hurling aloft screaming rockets on raging streamers of fire. The scientist stands on the brink of exciting adventures into the unknown as he peers into the heart of an atom or investigates the tremendous universe through which we cruise.

In a certain and very true sense we are all astronauts. Each morning the sun deposits a fresh day on the doorstep: to open the shutters of the mind, to let shine the golden light of truth, and to reveal to young people the magic and delight that crowd every minute with mystery and fascination. The enthusiastic science teacher can turn the classroom into a launching pad of exciting new ideas to boost the minds of the young into orbits of knowledge and inspiration, remembering always that every advance in science, every achievement in technology, every masterpiece of art comes from the mind.

The world breaks like an unceasing surf on the shores of young minds. In teaching students to observe, to think, to draw conclusions, the teacher's greatest stock in trade is the natural curiosity of the young. "We have just opened the door into the limitless reaches of the universe," says Dr. Wernher von Braun, America's foremost rocket expert. "We can see just far enough ahead to know that man is at the threshold of a momentous area. Here is opportunity, challenge, adventure so tremendous as to exceed anything that has gone before. Here is the tomorrow youth wants to embrace."

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Why study science?

Long before you were born Pope Pius XI wrote a letter on the education of youth. Thirty years later, in 1959, the International Office of Catholic Education held a meeting in The Netherlands to celebrate the anniversary of the publication of this letter. Pope John XXIII, the second pope after Pope Pius XI, sent a message to be read at the meeting. He praised the letter of Pope Pius and repeated some of the ideas that are found in it. But Pope John added one important idea that his predecessor had not included. He said that as many young Catholics as possible ought to enter the field of science. The pope is a spiritual guide. If he encourages you to become a scientist, you ought at least to think about the matter and learn something about the field in which he wishes young people to be interested. *

What is science?

An experienced taxicab driver knows the names and location of all the streets in a city and the best way to get from one point to another. He has a great fund of knowledge, but you do not call this knowledge science. A science is a body of knowledge based on facts and organized in such a way as to enable one to understand why things are as they are and to solve new problems concerning these observations. Each kind of science differs from every other in the facts about which it is concerned.

When the average person thinks about science, he is usually thinking of one of the physical sciences, which are concerned with matter and energy: physics with energy, its creation, transformation, effects, measurement, and control; chemistry with matter, its composition and changes; biology with living forces and living matter; astronomy with heavenly bodies and forces; mathematics with number and pure space. Each of the great sciences has some broad general theory; its facts and laws are organized according to this underlying principle. Thus the men who signed the Declaration of Independence declared that all men were

created by God with rights that could not be taken away from them, and that these truths were self-evident.

Ordinary observation can teach you very much about the power, wisdom, and goodness of God. It is enough to lift your eyes toward the vast expanse of the heavens or to let them fall upon the delicate and beautiful flowers that grow at your feet. But science reveals things about the works of God that you could never know otherwise. Moreover, science can show you how to take material things and make them work for you rather than against you. Science will answer thousands and thousands of questions about which you have been curious.

How far away is the sun? Why is the sun hot, and why has it not lost all its heat after so many millions of years? Why does the moon not fall into the earth? What is electricity? What is fire? Why is water wet? What causes a tornado? How can a television set pick up pictures from the air? Why do brothers and sisters so often look alike? What can I do to improve my memory? These are only a few samples of the questions that science answers.

The study of science is interesting, not dull. You cannot read a newspaper intelligently unless you know something about science. Persons who know nothing about science make stupid, costly, and often fatal mistakes.

The field of science

Terence, a Roman poet who lived two thousand years ago, said: "I am a man, and nothing that concerns man is a matter of indifference to me." This remark should have meaning for you. It is similar to something taught by Christ. Our Lord declared that every human being upon the face of the earth is a neighbor whom one ought to love and that no man would be worthy of the name Christian unless he had made some contribution to mankind.

If this is true, it follows that you ought to take an interest in everything that affects the welfare of mankind in a large way. Strangely enough, there are persons living today who do not believe in science and who seem to suspect scientists. Others go to the opposite extreme. They appear to think that science alone can give the right answer to any question, no matter what it is. Both these attitudes are wrong.

The correct attitude is that science is rendering a most useful service toward mankind and, when properly used, can draw you

closer to God. Whatever science studies is a work of God. Man alone, of all the creatures on earth, has a mind that can understand God and a free will that can praise God. Man ought therefore to study God's great design, ought to strive to understand what God did and what God's purpose was. When the first man was created God commanded him, and his descendants through him, to take care of the home that had been made for him. If God put wonderful riches in the world that He made for man, He must surely wish man to discover and use these riches.

Scientific knowledge differs from other kinds of human knowledge not only in its organization and basic theories, but also in these areas: (1) in the *way it originates*, for scientific knowledge comes from careful observation under controlled conditions, from conclusions or generalizations based on what has been observed, and from testing; (2) in its *subject matter*, for science is not concerned with life in general or with the world in general but with some particular aspect, such as matter and energy; (3) in its *principles*, among which are the principle that knowledge must result from observation, the principle that there must be measurement and testing, the principle that proofs must be given, and the principle that theories and conclusions must be verified; (4) in its *techniques and skills*, for every science has its own ways of setting up an experiment and of putting matter and energy to work in such a manner as to force them to reveal their true nature; and finally (5) in its *methods*, for the scientific method is a method of discovery, of reasoning, and of verification.

Methods of science

The scientific method is a method of *discovery*. The scientist wishes to discover facts, but he is not interested in facts as isolated events. He is interested rather in types. A scientist is likewise interested in laws. Boyle's law, for example, states that if any gas is kept at a constant temperature and subjected to pressure, the volume of the gas decreases as the pressure increases. Laws of this kind are very frequently expressed as mathematical equations. The formula of Boyle's law may be written as $PV = K$ (pressure times volume is always constant).

The scientific method is a method of *reasoning*. Of course, any human being who wishes to do a thing well must reason. A quarterback reasons before he calls the next play. A businessman

reasons before he invests his money. You will even wash dishes better if you “use your brains.” Science, then, does not have a monopoly on reasoning. But there is one kind of reasoning that is peculiar to science, and that is reasoning through the formulation of theories. A theory is an explanation for things which happen that might very well be true but has not as yet been proven true. By assuming that the theory is true, you may be able to discover new facts. Two theories that are helping progress today are the atomic theory of matter and the particulate theory of energy, the theory that radiant energy is emitted in separate packets.

The scientific method is a method of *verification*. To verify a thing is to prove that it is true. Science verifies its theories and proves its conclusions or findings chiefly by controlled experiments. An experiment is an operation designed to test or study some theory. Its characteristics are: (1) the use of carefully designed apparatus, (2) thorough observation, (3) measurement as exact as possible, and (4) conclusions based solely on what was observed or measured.

It would be difficult to name any science that has not developed rapidly and wonderfully in recent years. A science develops because trained men and women take one thing at a time and work at it. They ask themselves three questions: What is this thing? How does it behave? Why does it behave as it does? These workers gather all the facts they can. They classify these facts as far as possible. They begin to see constant patterns in the results that follow or in ways of behaving. Theories are suggested to explain why these patterns exist. These theories are constantly tested by means of experiments. Test! Test! Test!—this is the great principle by which a scientist lives. The conclusions, when once shown to be constant, become the laws of science, often expressed in mathematical formulas. In the end a theory may be shown to be true, something new is given to the human race. Thus science has shown how to control polio, how to build a jet plane, and how to set a satellite in motion around the sun.

The Catholic student and science

Some professions are so overcrowded that success is difficult, but the openings in sciences are unlimited. There are still new worlds to conquer in space, in the air, on the land, under the water, under the microscope, in the test tube, or in the great elec-



Would jet planes now circle the world if young people had never been interested in science courses?

tronic machines that do the work of men so well that they are called electronic brains. There are students in your class who might perhaps become known throughout the world for their discoveries. But it should be remembered that one can become a well-trained scientist and a valuable one without being so great that he makes startling discoveries. It requires scientific training to be able to use intelligently the things that have already been developed and to make improvements in them.

You must recognize the fact that not everyone prefers science to all other types of work. The world still needs poets, musicians, artists, architects, lawyers, priests, teachers, nurses, actors, and many other kinds of workers. Pope John did not advise *everyone* in a Catholic school to become a scientist; he hoped that *many* would enter the field. And the pope made it quite clear that he expected students who became scientists to be good scientists. Today there are scientists who think that nothing can be accepted as true unless science has proved it to be true. But while the physical sciences have given the world thousands upon thousands of very useful discoveries and laws that help men to live, they do not provide answers to the most important questions of all. Is it true that all men are created equal and that they have a right to

life, liberty, and the pursuit of happiness? That question can be answered, and answered so clearly and positively that every intelligent and honest person must accept the answer—but not by a physical science. Spiritual beings and spiritual laws which govern the human mind are simply of no concern to the scientist whose work pertains to matter and energy. Science can make atom bombs, but science cannot tell when it is right and when it is wrong to use atom bombs. If a scientist does answer that question, he is not speaking as a scientist but as a person who knows what can be proved from ethics, from philosophy, and from the revealed religion of God.

The world of science is so vast, so tremendous, that it cannot be captured between the pages of one textbook such as this. Form the habit of constantly expanding your knowledge of this exciting and fascinating field by reading scientific articles that appear in magazines and newspapers. In addition, treat yourself to a book of science now and then. Books are doors to wide new worlds.

Stephen Kelley

With all

Best wishes

from

John M. Holt, S. 9.